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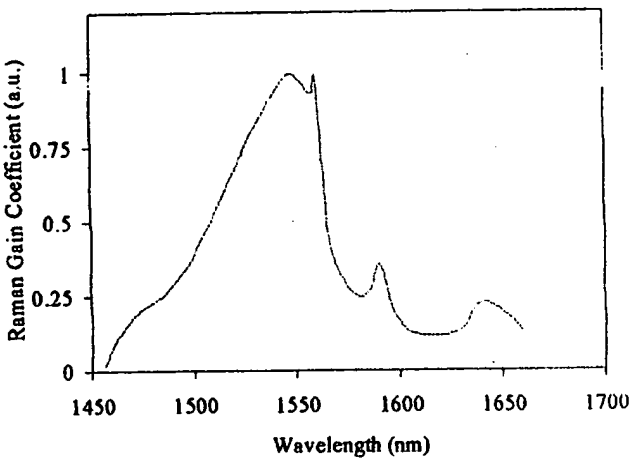


Figure 1 - Normalized Raman Gain Spectrum of standard single mode fiber. Pump wavelength is at 1450 nm.

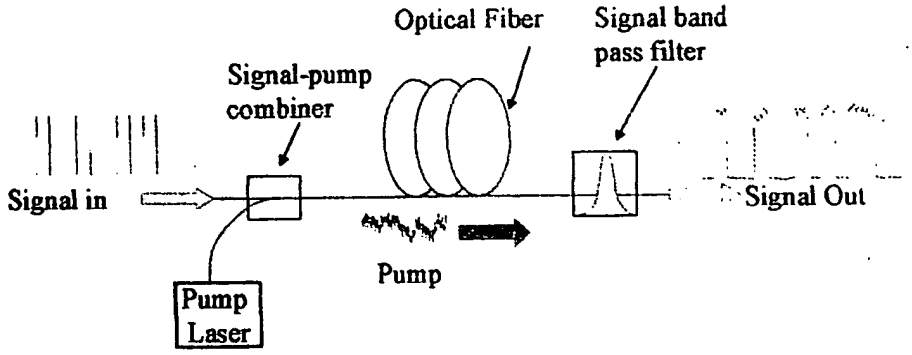


Figure 2 - Distributed Raman amplification using forward pump (co propagating pump and signal). The noise of pump and signal beams are schematically drawn.

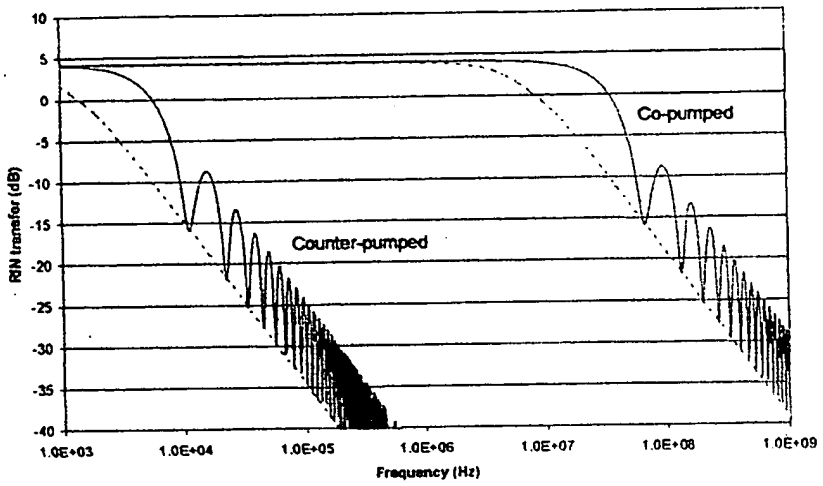


Figure 3 - RIN transfer spectrum for a co- and counter-pumped Raman amplifier with 10 dB of gain. Pump attenuation=0.29 dB/km, length=10 km (solid line) and 80 km (dotted line), dispersion =15.6 ps.nm km^{-1}, pump at 1455 nm and signal at 1555 nm [5].

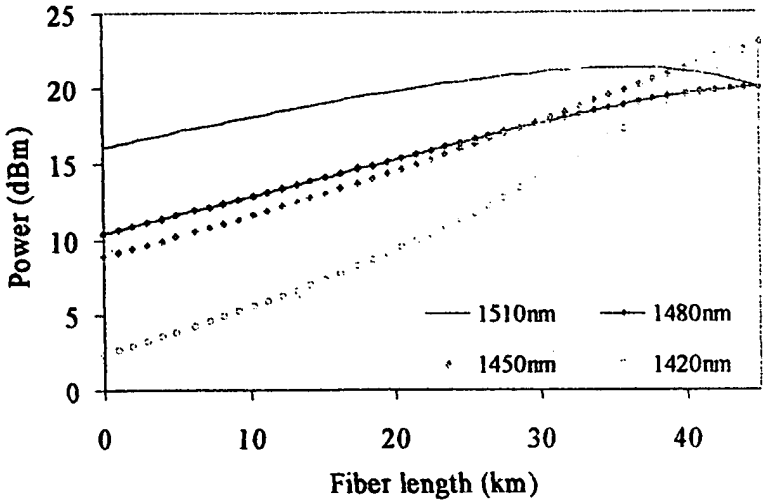
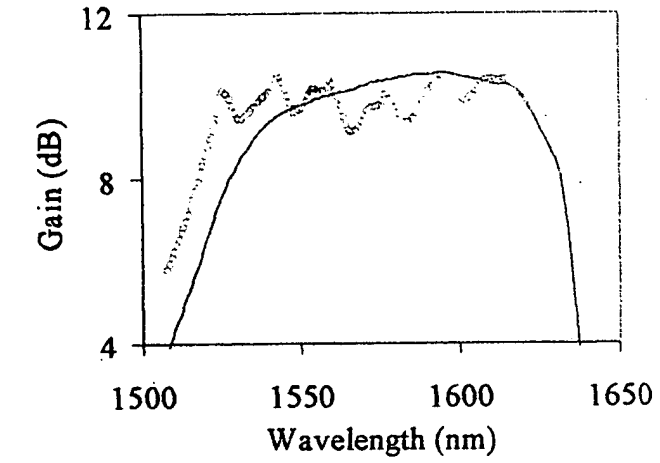
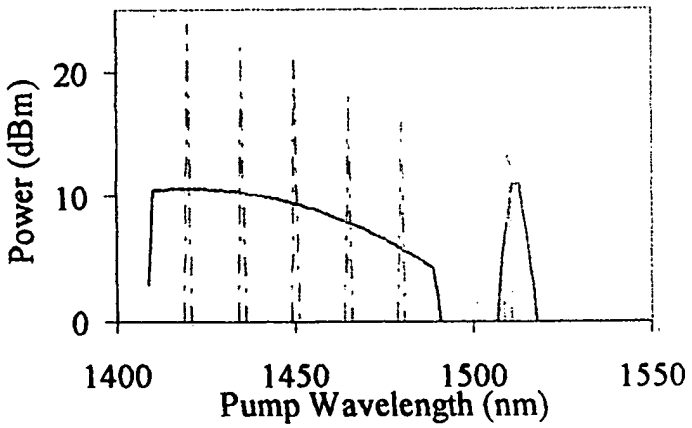


Figure 4 - Power evolution of pump diode lasers along the fiber path. The pump wavelengths are: 1420 nm, 1450nm, 1480nm, and 1510nm. The longer wavelength pump (1510 nm) is amplified by the short wavelength pumps.



(a)



(b)

Figure 5 - Simulated Raman gain shape (a) achieved using 6 discrete pump wavelengths (open dots) and that with 2 broadband sources (solid curve). The pump wavelength and power distribution are shown in the lower plot (b).

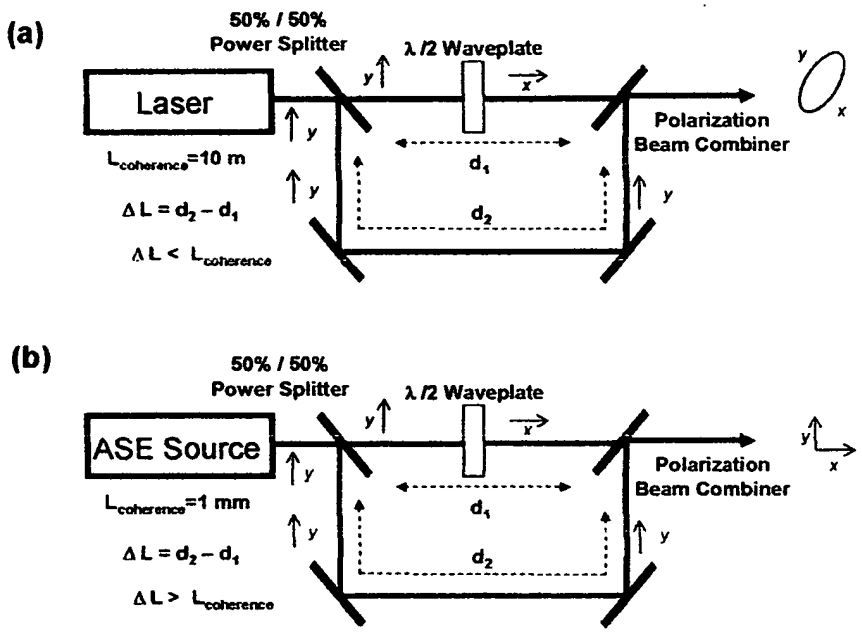


Figure 6 - Schematic of the optical elements of a depolarizer and a pictorial illustration of polarization state for (a) long and (b) short coherence sources.

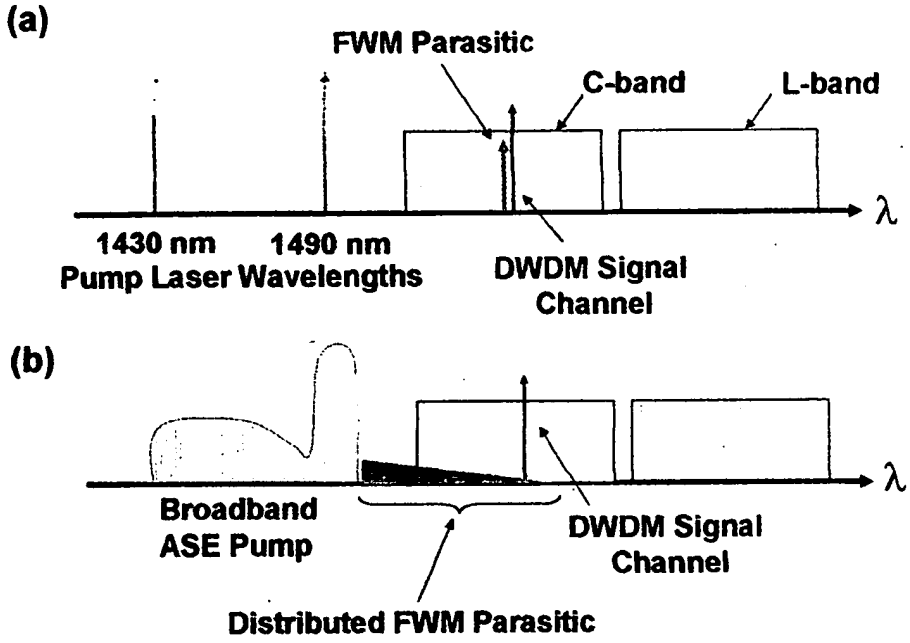


Figure 7– Illustration of the reduction of FWM achieved in a Raman amplifier pump with a (a) discrete wavelengths and with (b) broadband ASE source as compared to a Raman amplifier pumped. The broadband ASE pump in figure (b) is sketched only graphically.

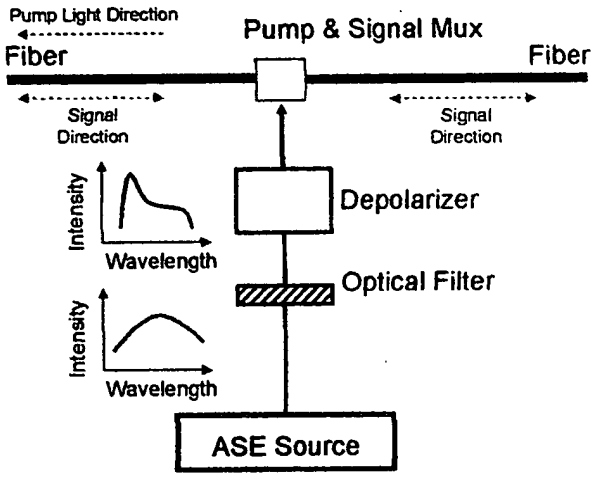


Figure 8- Block Schematic of Broadband ASE Raman Pump Source (Forward or Backward Pumping)

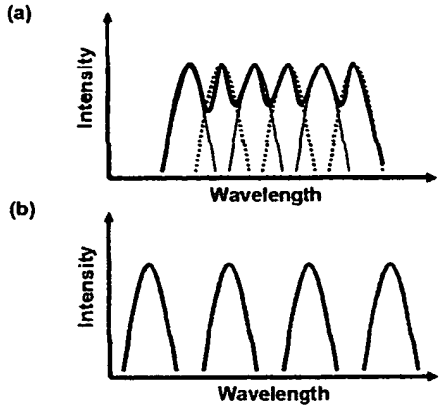


Figure 9 – Illustration of how multiple filtered or unfiltered narrow bandwidth (e.g. 3-40 nm) ASE sources can be superimposed to form a (a) continuous or (b) discontinuous high power ASE spectrum for Raman pumping.

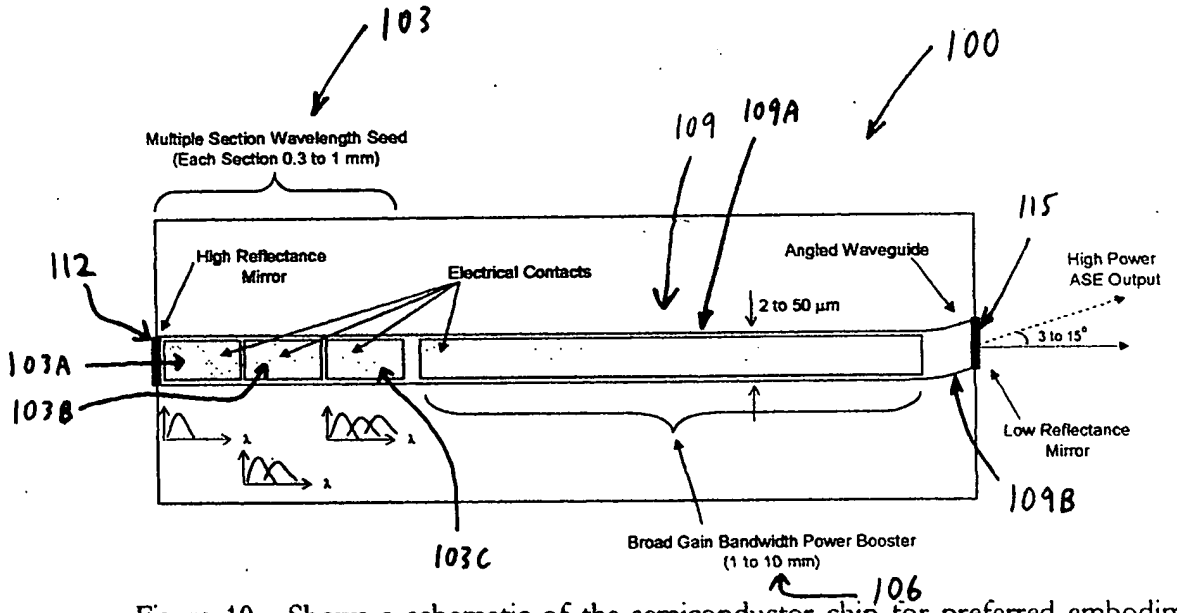


Figure 10 - Shows a schematic of the semiconductor chip for preferred embodiment #1. The chip consists of a serial connection of a wavelength seed section and a power booster or power amplification section.

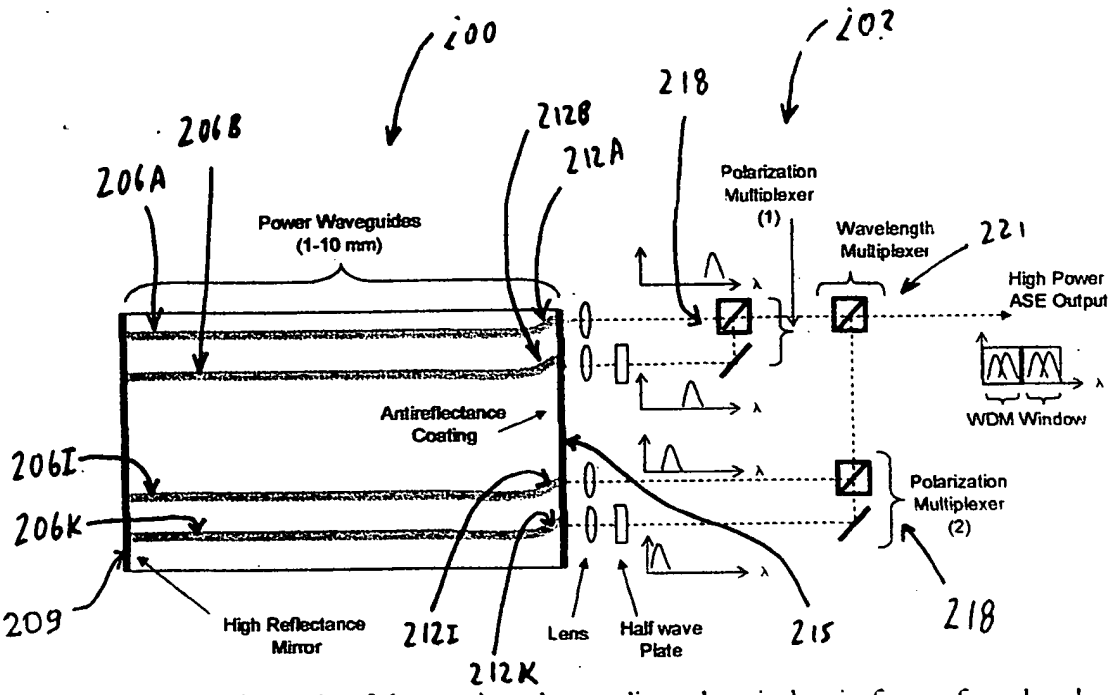


Figure 11- A schematic of the semiconductor die and optical train for preferred embodiment #2

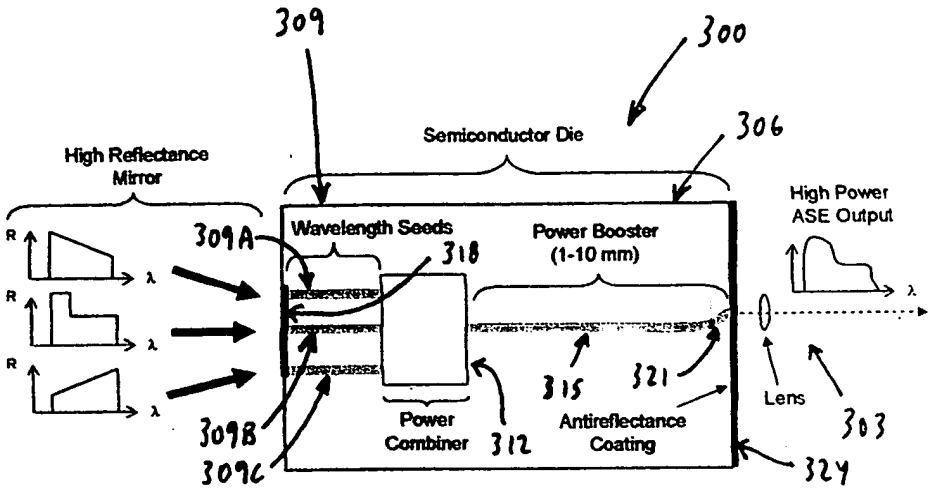


Figure 12 - Schematic of the semiconductor die and optical train for preferred embodiment #3.

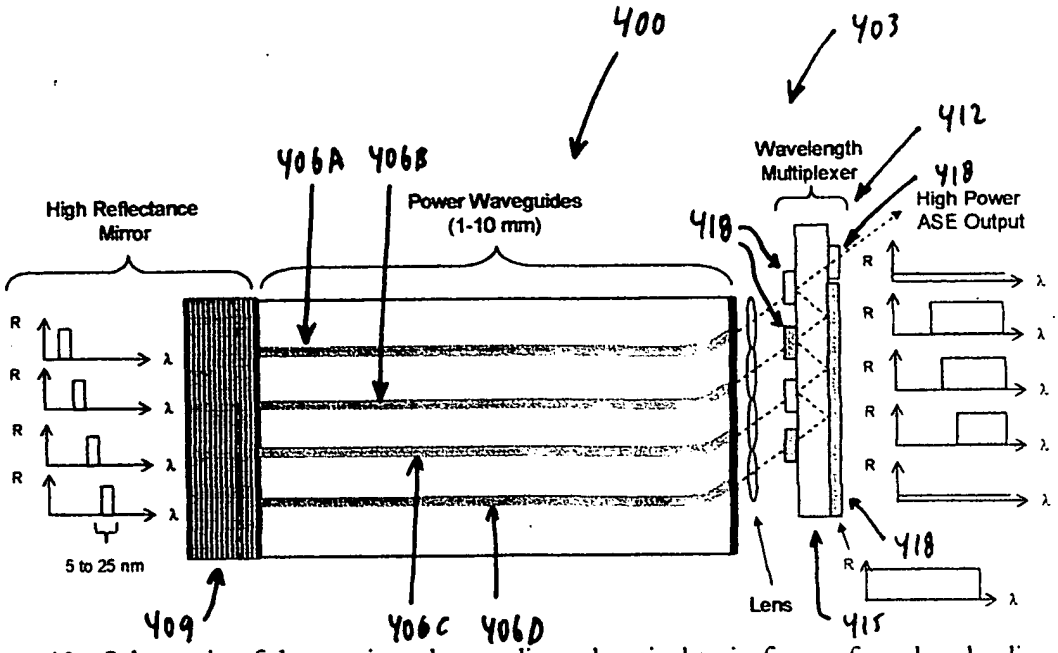


Figure 13 - Schematic of the semiconductor die and optical train for preferred embodiment #4.

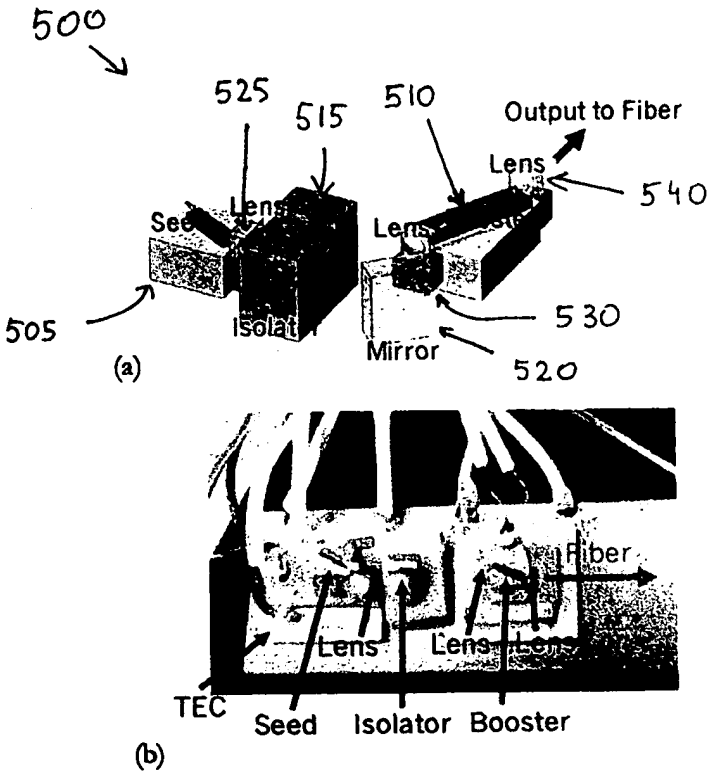


Figure 14 - The Use of a Discrete Seed and Booster to Gernerate High Power ASE. (a) shows the schematic of the experimental setup and (b) presents a photograph of the actual microoptical bench setup.

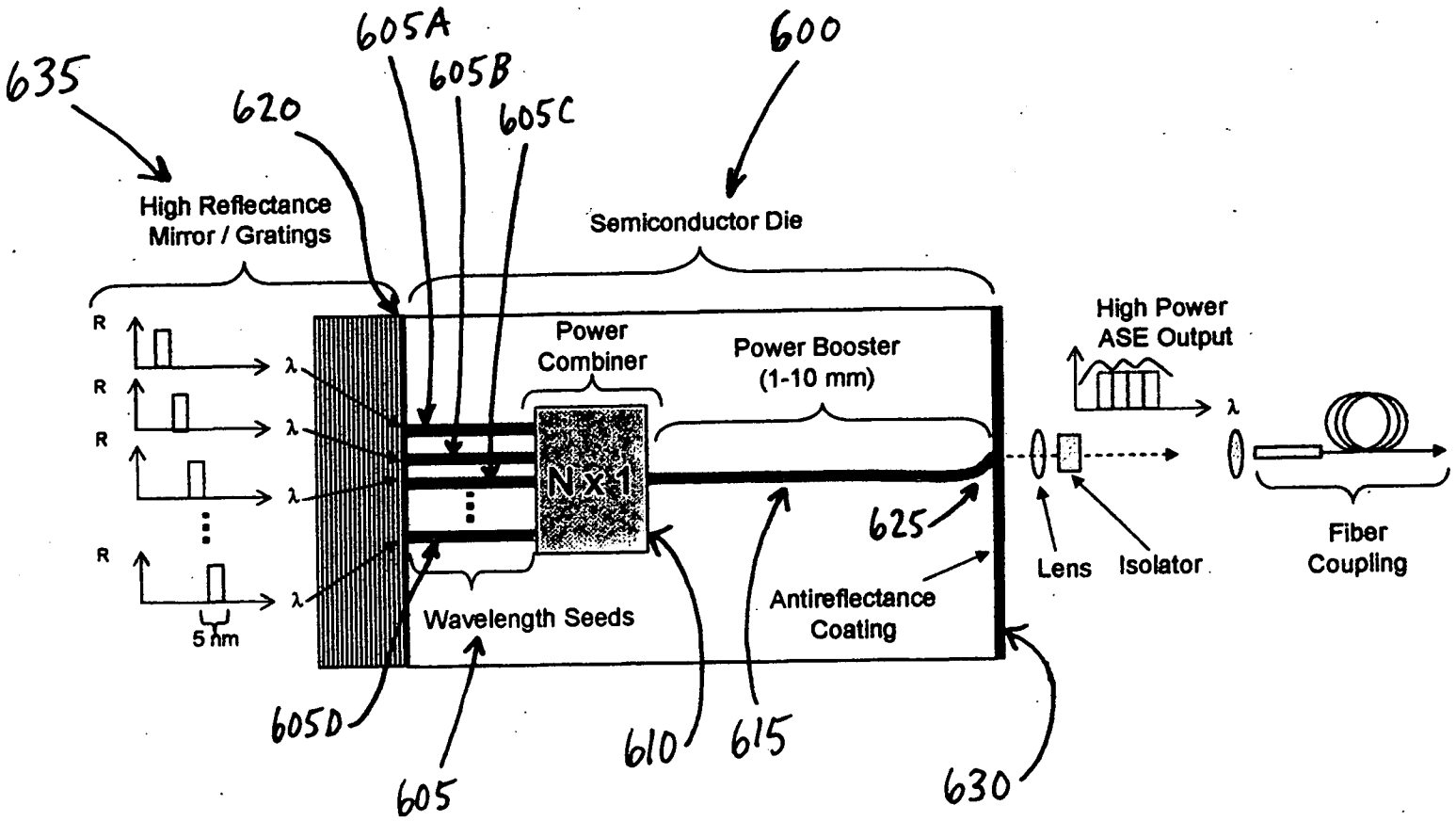

635
620
605A
605B
605C
600
High Reflectance
Mirror / Gratings
Semiconductor Die
R
λ
5 nm
Power
Combiner
Power Booster
(1-10 mm)
N x 1
High Power
ASE Output
625
Lens
Isolator
Fiber
Coupling
Wavelength Seeds
Antireflectance
Coating
605D
605
610
615
630

Fig. 15

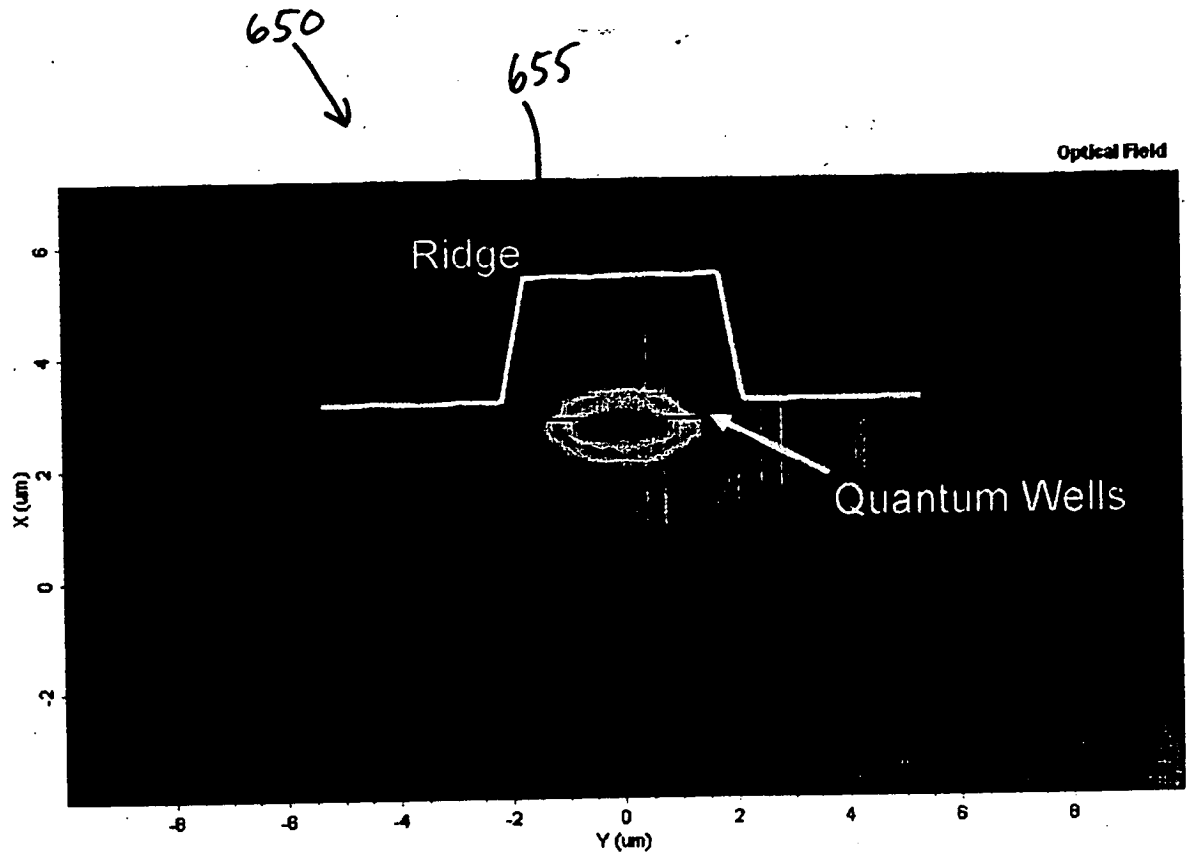

650
655
Optical Field
Ridge
Quantum Wells
X (um)
Y (um)
6
4
2
0
-2
-8
-6
-4
-2
0
2
4
6
8

Fig. 16

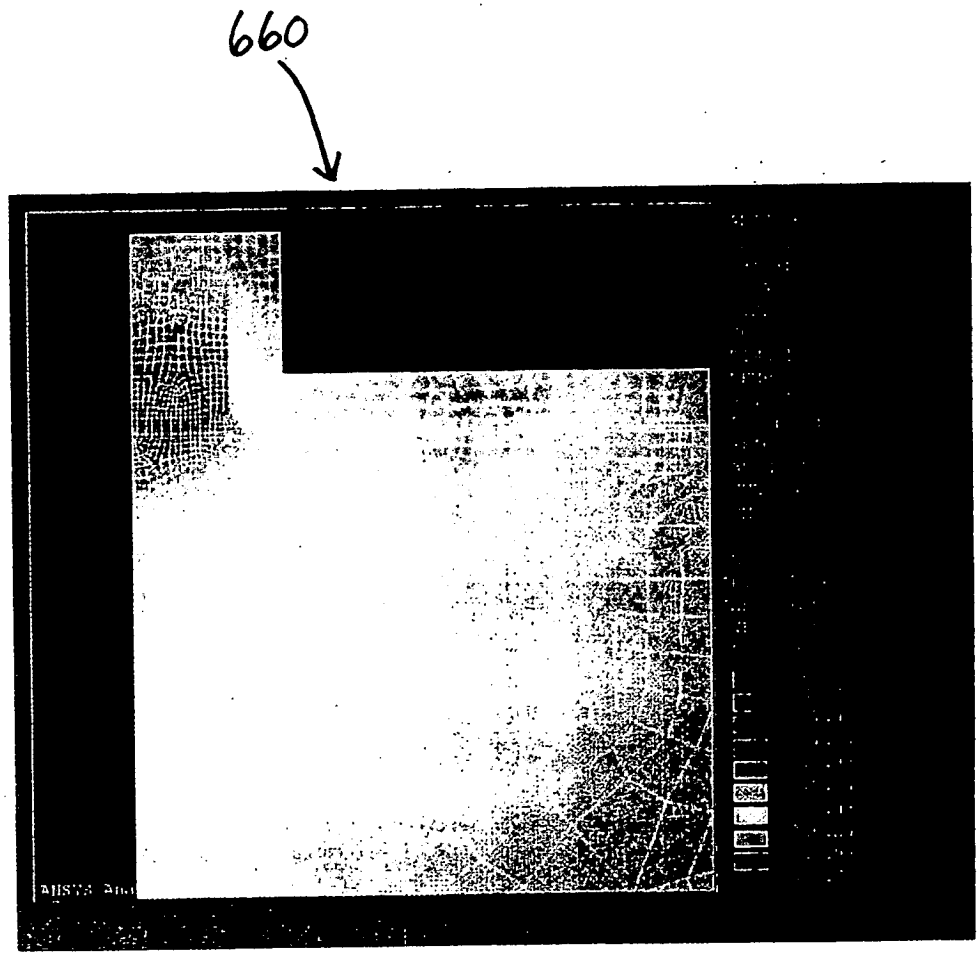


Fig. 17

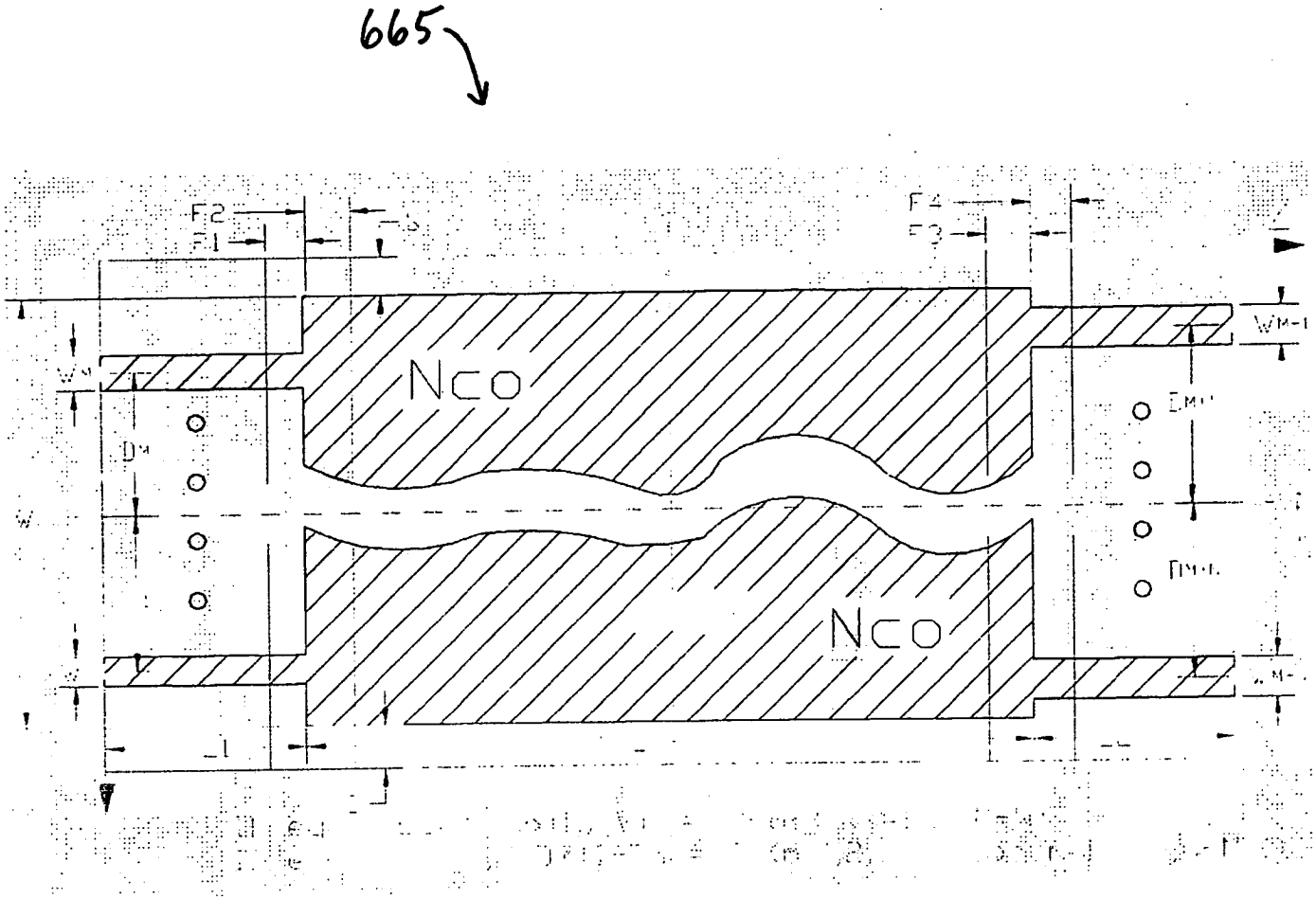


Fig. 18

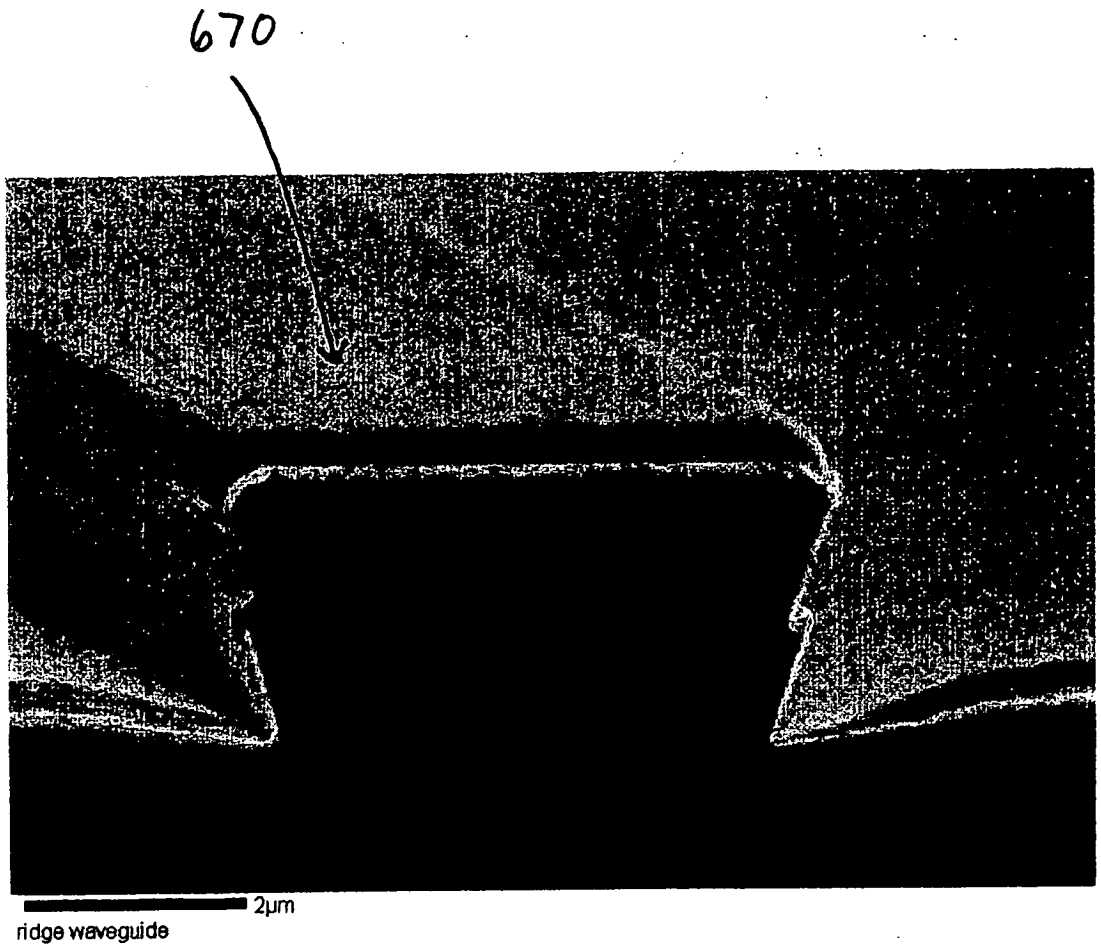


Fig. 19

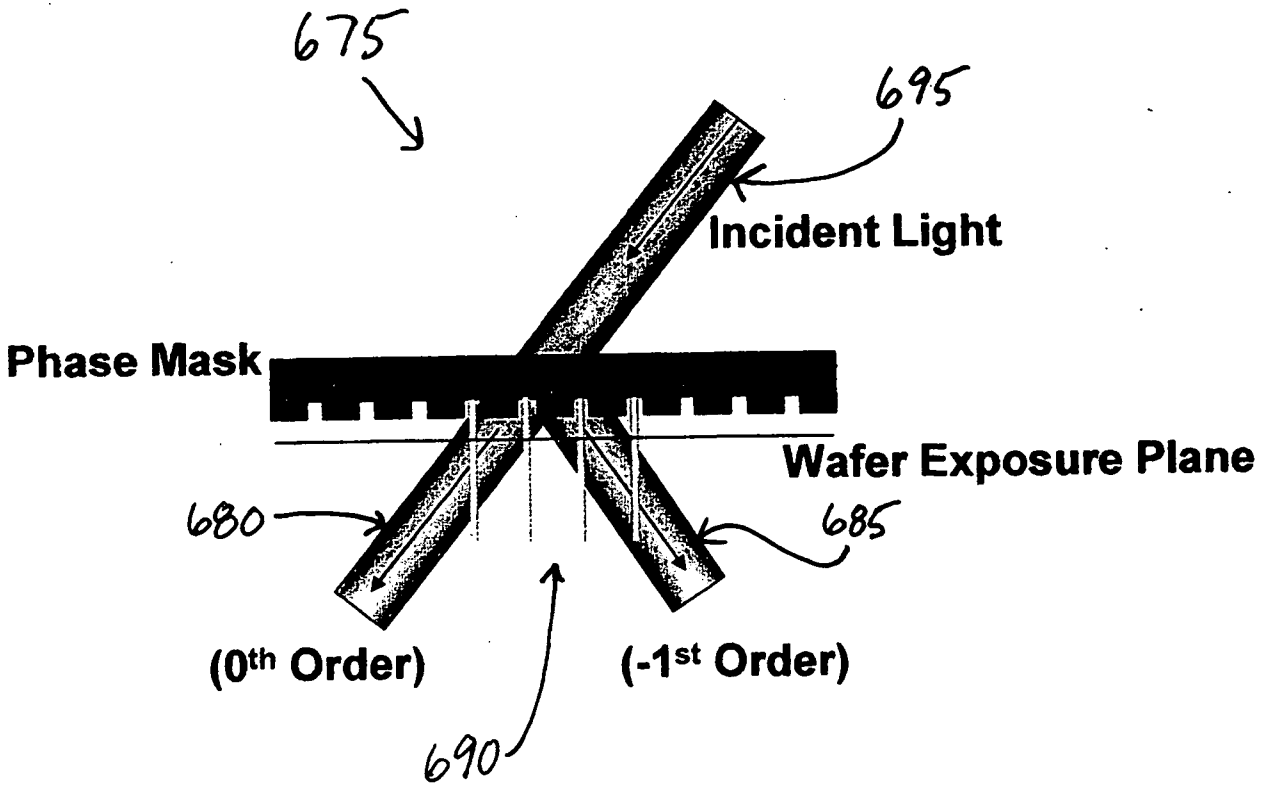

675
695
Incident Light
Phase Mask
Wafer Exposure Plane
680
685
(0th Order)
(-1st Order)
690

Fig. 20

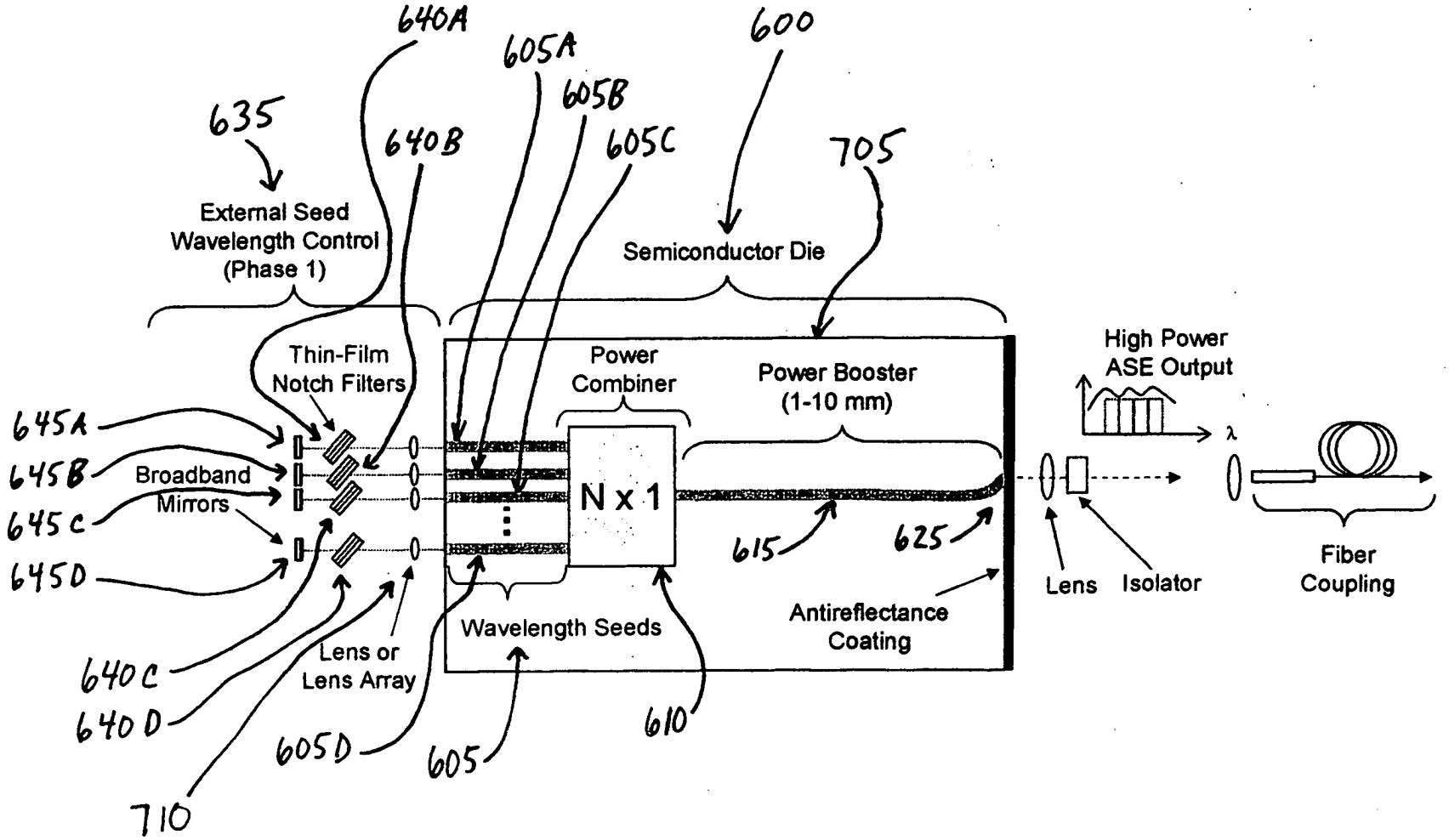

640A
605A
600
635
605B
640B
605C
705
External Seed
Wavelength Control
(Phase 1)
Semiconductor Die
Thin-Film
Notch Filters
Power
Combiner
Power Booster
(1-10 mm)
High Power
ASE Output
λ
645A
645B
Broadband
Mirrors
645C
645D
N x 1
615
625
Lens
Isolator
Fiber
Coupling
Antireflectance
Coating
Wavelength Seeds
640C
640D
Lens or
Lens Array
605D
605
610
710

Fig. 21

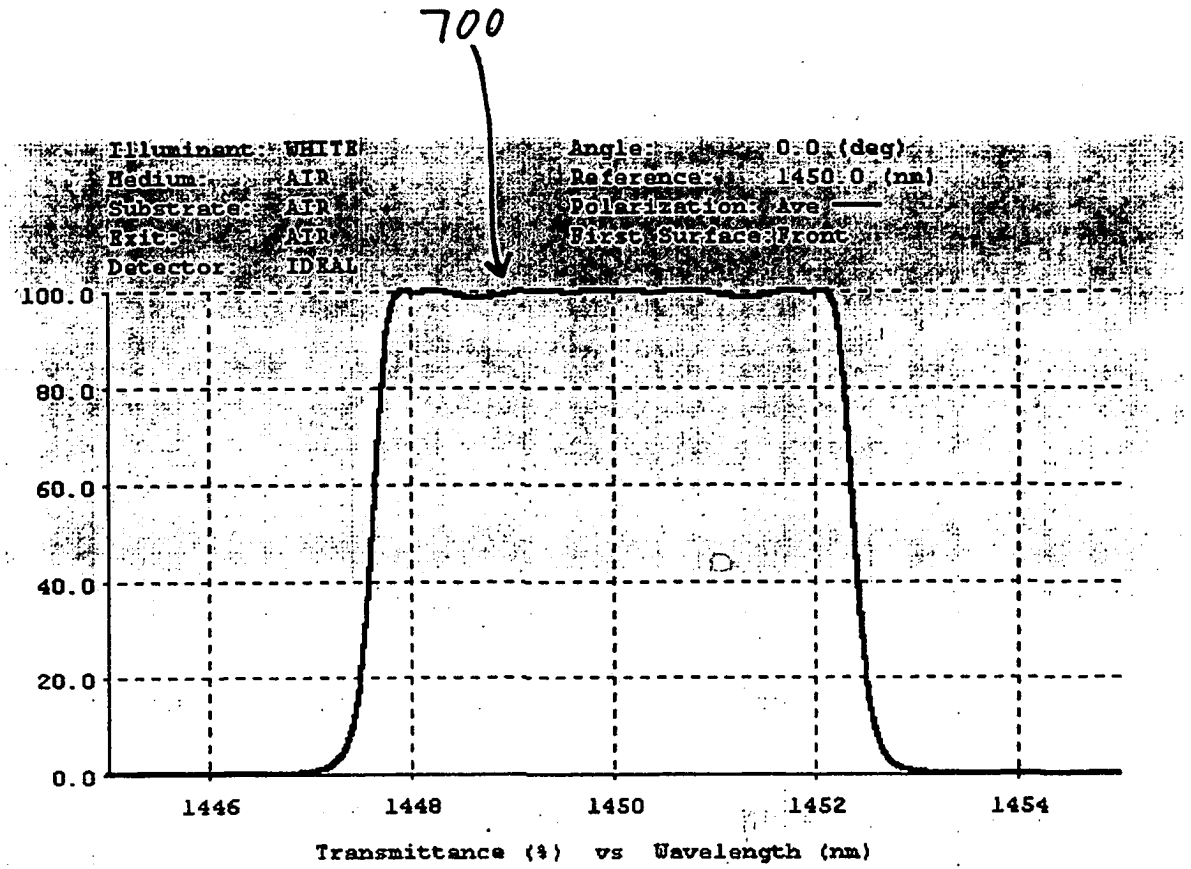

700
Illuminant: WHITE
Medium: AIR
Substrate: AIR
Rxic: AIR
Detector: IDRAL
Angle: 0.0 (deg)
Reference: 1450.0 (nm)
Polarization: Ave
First Surface:Front
100.0
80.0
60.0
40.0
20.0
0.0
1446
1448
1450
1452
1454
Transmittance (%) vs Wavelength (nm)

Fig. 22

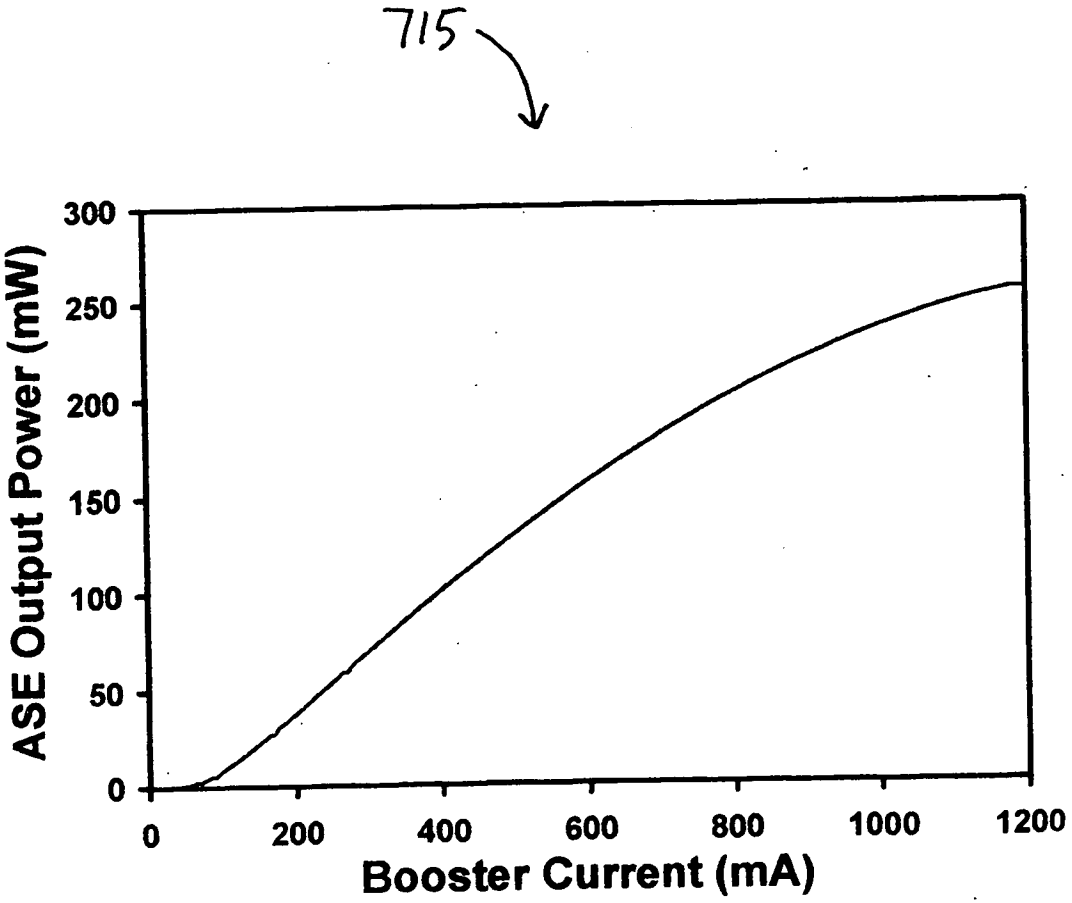

715
ASE Output Power (mW)
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
Booster Current (mA)

Fig. 23

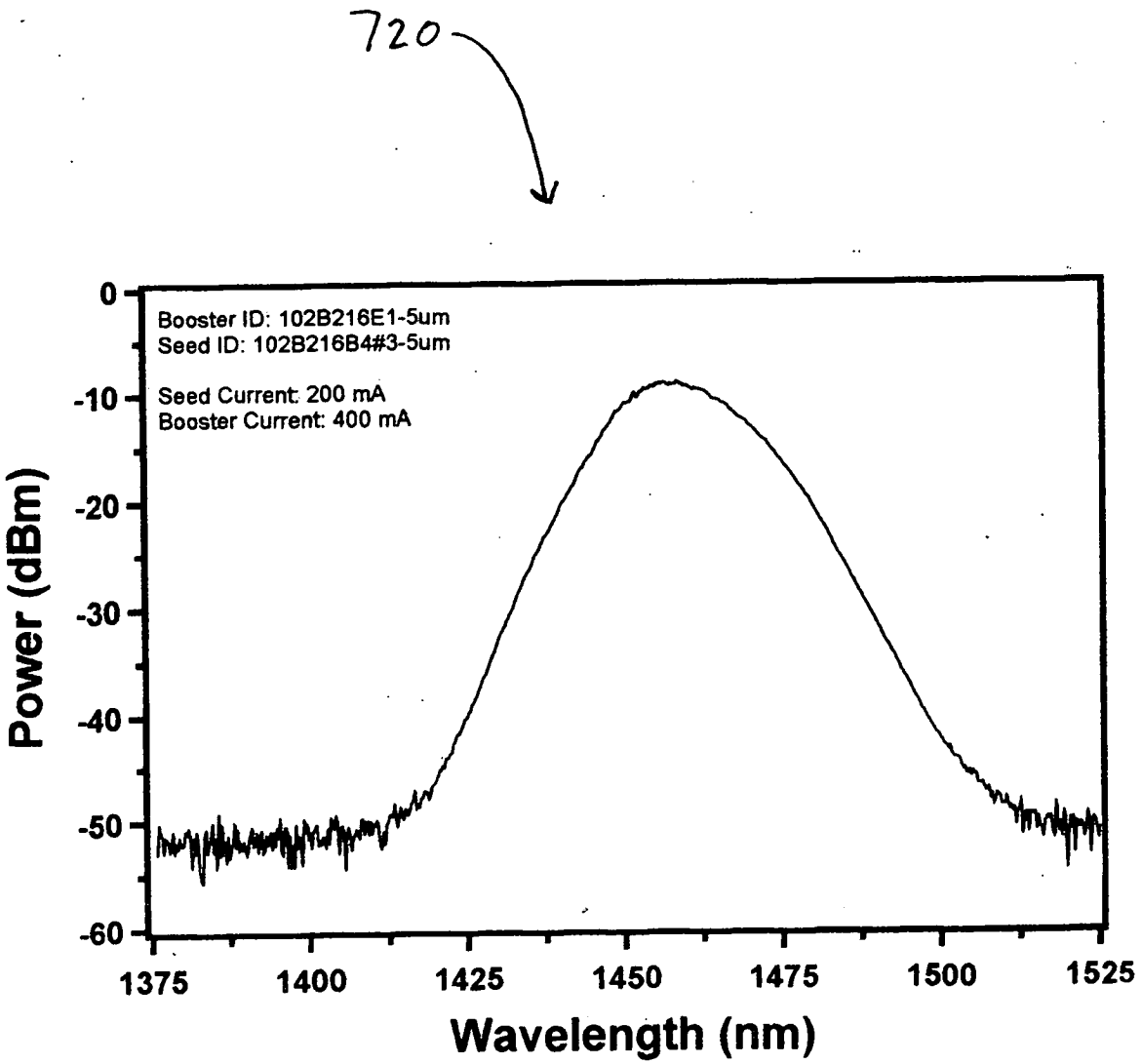

720
Booster ID: 102B216E1-5um
Seed ID: 102B216B4#3-5um
Seed Current: 200 mA
Booster Current: 400 mA
Power (dBm)
0
-10
-20
-30
-40
-50
-60
1375
1400
1425
1450
1475
1500
1525
Wavelength (nm)

Fig. 24